

# PATENT COOPERATION TREATY

HS/GS

From the INTERNATIONAL SEARCHING AUTHORITY

To:  
HARRY F. SMITH  
HARRINGTON & SMITH, LLP  
4 RESEARCH DRIVE  
SHELTON, CT 06484-6212

## PCT

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL SEARCH REPORT AND  
THE WRITTEN OPINION OF THE INTERNATIONAL  
SEARCHING AUTHORITY; OR THE DECLARATION

(PCT Rule 44.1)

US ACTION  
DUE DATE 4-8-05  
PAPER DATED 2-8-05  
CA FINAL  
MSG PT DWG

Date of mailing  
(day/month/year) **08 FEB 2005**

Applicant's or agent's filing reference  
873.0119.U1(WO) OTHER 02-19 INS-IDS

**FOR FURTHER ACTION** See paragraphs 1 and 4 below

International application No.  
PCT/IB04/01566

International filing date  
(day/month/year) 14 May 2004 (14.05.2004)

Applicant  
NOKIA CORPORATION

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes  
1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.
3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
- ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

### 4. Reminders

Shortly after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise, the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US  
Mail Stop PCT, Attn: ISA/US  
Commissioner for Patents  
P.O. Box 1430  
Alexandria, Virginia 22313-1430

Facsimile No. (703) 305-3230

Form PCT/ISA/220 (January 2004)

Authorized officer

Kevin M. Burt

Telephone No. 703-203-4900

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FEB 14 2005

HARRINGTON & SMITH, LLP

(See notes on accompanying sheet)

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 873.0119.U1(WO)	<b>FOR FURTHER ACTION</b>	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/IB04/01566	International filing date (day/month/year) 14 May 2004 (14.05.2004)	(Earliest) Priority Date (day/month/year) 30 May 2003 (30.05.2003)
Applicant NOKIA CORPORATION		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of

4

sheets.

## 1. Basis of the Report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ The international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (See Box No. II)

3. ☐ Unity of invention is lacking (See Box No. III)

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

- a. the figure of the drawings to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB04/01566

## Box IV TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

## NEW ABSTRACT

A signal constellation (50) for a multiple input/multiple output (MIMO) communication system (20) when channel knowledge at the receiver is imperfect includes at least two (n-1)-dimensional sub-constellations of points that together form an n-dimensional constellation (50), the number n representing real dimensions and  $n = 2M$  where M is the number of transmitting antennas (26). The n-dimensional spherical constellation (50) may define a single sphere or a plurality of concentric subset spheres, and points between the subsets are separated by a Kullback-Leibler distance rather than a Euclidian distance. Each sphere has sub-constellations that preferably are arranged in symmetric pairs that define equal numbers of points that lie in parallel planes, to allow recursive construction that minimizes computational complexity. An appropriate constellation may be chosen by ceasing a search once the optimum distance stops increasing as a number of the concentric levels increases.

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB04/01566

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H04L 1/02

US CL : 375/267

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 375/267, 259, 316, 346, 347.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Confirmation Sheet

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2001/0031019 A1 (JAFARKHANI et al ) 18 October 2001 (18.10.2001), figures 1 and 2; paragraphs 0009, 0011, 0012, 0028, 0050 and claim 9.	1-8, 12-13, 23-28, 32
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Y		9-11, 14-22, 29-31
Y,P	US 2003/0123877 A1 (LO) 3 July 2003 (03.07.2003), figures 4A-4D; paragraphs 0028-0032.	9, 10, 16, 29, 30
Y,P	US 2003/0210824 A1 (FALZON et al) 13 November 2003 (13.11.2003), abstract; paragraphs 0021 and 0024.	11, 14-22, 31
Y	US 2002/0114378 A1 (YUE) 22 August 2002 (22.08.2002), paragraph 0017.	11, 14, 15, 17-22, 31
A	US 4,891,823 A (COLE) 2 January 1990 (02.01.1990), column 1, lines 13-41.	1-32

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

\* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*B\* earlier application or patent published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reasons (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later documents published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

\*Z\* document member of the same patent family

Date of the actual completion of the international search

01 January 2005 (01.01.2005)

Name and mailing address of the ISA/US

Mall Stop PCT, Attn: ISA/US

Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

Facsimile No. (703) 305-3230

Date of mailing of the international search report

08 FEB 2005

Authorized officer:

Kevin M. Burd

Telephone No. 703-305-4900

**INTERNATIONAL SEARCH REPORT**

International application No.  
PCT/IB04/01566

Continuation of B. FIELDS SEARCHED Item 3:

cast

search terms: sphere, antenna, dimension, real

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

To:  
HARRY F. SMITH  
HARRINGTON & SMITH, LLP  
4 RESEARCH DRIVE  
SHELTON, CT 06484-6212

## PCT

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing  
(day/month/year) **08 FEB 2005**

FOR FURTHER ACTION

See paragraph 2 below

Applicant's or agent's file reference

873.0119.U1(WO)

International application No.

International filing date (day/month/year)

Priority date (day/month/year)

PCT/IB04/01566

14 May 2004 (14.05.2004)

30 May 2003 (30.05.2003)

International Patent Classification (IPC) or both national classification and IPC

IPC(7): H04L 1/02 and US CL.: 375/267

Applicant

NOKIA CORPORATION

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**FEB 14 2005**

HARRINGTON & SMITH, LLP

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

FOR FURTHER ACTION

DUE DATE

PAPER DATED

OA

MSG PT

APPEAL

OTHER

5-8-05

2-8-05

INAP

DWG

ISSUE FEE

Written Opinion

### 2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/ US

Mail Stop PCT, Attn: ISA/US  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
Facsimile No. (703) 305-3230

Authorized officer

Kevin M. Burd

Telephone No. 703-305-4900

Form PCT/ISA/237 (cover sheet) (January 2004)

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/IB04/01566

Box No. 1 Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This opinion has been established on the basis of a translation from the original language into the following language \_\_\_\_\_, which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).

2. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

a. type of material

☐ a sequence listing

☐ table(s) related to the sequence listing

b. format of material

☐ in written format

☐ in computer readable form

c. time of filing/furnishing

☐ contained in international application as filed.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.  
PCT/IB04/01566

Box No. V Reasoned statement under Rule 43 *bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)

Claims 9-11, 14-22, 29-31 YES

Claims 1-8, 12-13, 23-28, 32 NO

Inventive step (IS)

Claims 9, 10, 16, 29, 30 YES

Claims 1-8, 11-15, 17-28, 31, 32 NO

Industrial applicability (IA)

Claims 1-32 YES

Claims NONE NO

2. Citations and explanations:

Please See Continuation Sheet



WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.  
PCT/IB04/01566

Supplemental Box  
In case the space in any of the preceding boxes is not sufficient.

V. 2. Citations and Explanations:

Claims 1-8, 12, 13, 23-28 and 32 lack novelty under PCT Article 33(2) as being anticipated by Jafarkhani et al (US 2001/0031019).

Regarding claims 1, 13, 23 and 28, Jafarkhani disclosed a multiple input multiple output communication system as shown in figures 1 and 2. The system communicates using symbols that are mapped via space-time block code onto constellation points and are transmitted over  $n$  transmitting antennas (paragraph 0012). Each of the constellation points lie on a  $k$ -dimensional transmit circle (paragraph 0028). The dimensions are real dimensions (paragraphs 0009, 0050 and claim 9). Each of the antennas will transmit a constellation thus increasing the number of dimensions by the number of antennas.

Regarding claim 2, each of the antennas will transmit a constellation thus increasing the number of dimensions by the number of antennas.

Regarding claim 3, figure 1 shows  $n$  can be any value greater than 1.

Regarding claims 4 and 25, the parallel antennas will transmit separate constellations parallel to one another.

Regarding claims 5-8, 26 and 27, each of the constellation points lie on a  $k$ -dimensional transmit circle (paragraph 0028) and the antennas transmit the same information.

Regarding claim 12, the points of the constellations are formed in the compute symbols 15 component of the transmitter in figure 1.

Regarding claim 24, the network comprises a base and mobile station as shown in figures 1 and 2.

Regarding claim 32, the signal-to-noise is computed and helps to determine the signal constellations to be transmitted (paragraph 0011).

Claims 11, 14, 15, 17-22 and 31 lack an inventive step under PCT Article 33(3) as being obvious over Jafarkhani et al (US 2001/0031019) in view of Yue (US 2002/0114378).

Regarding claims 11 and 31, Jafarkhani discloses the system described in paragraph 2. Jafarkhani does not disclose the distance between the points is defined by a Kullback-Leibler distance. Yue discloses a system for data transmission (abstract) utilizing the Kullback-Leibler distance (paragraph 0017). It would have been obvious for one of ordinary skill in the art at the time of the invention to utilize the method of minimizing the Kullback-Leibler distance as taught by Yue in the system of transmitting information of Jafarkhani. Yue states the Kullback-Leibler distance is well known in the art of mathematics and information theory and easy to compute (paragraph 0017).

Regarding claims 14 and 17-22, Jafarkhani discloses the system described in paragraph 2. In addition, each of the constellation points lie on a  $k$ -dimensional transmit circle (paragraph 0028) and the antennas transmit the same information. Jafarkhani does not disclose the distance between the points is defined by a Kullback-Leibler distance. Yue discloses a system for data transmission (abstract) utilizing the Kullback-Leibler distance (paragraph 0017). It would have been obvious for one of ordinary skill in the art at the time of the invention to utilize the method of minimizing the Kullback-Leibler distance as taught by Yue in the system of transmitting information of Jafarkhani. Yue states the Kullback-Leibler distance is well known in the art of mathematics and information theory and easy to compute (paragraph 0017).

Regarding claim 15, each of the constellation points lie on a  $k$ -dimensional transmit circle (paragraph 0028).

**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

International application No.  
PCT/IB04/01566

**Supplemental Box**

In case the space in any of the preceding boxes is not sufficient.

Claims 9, 10, 16, 29 and 30 meet the criteria set out in PCT Article 33(2)-(3) because the prior art does not teach or fairly suggest spherical constellations.

Claims 1-32 the criteria set out in PCT Article 33(4), and thus meet industrial applicability because the subject matter claimed can be made or used in industry.

## NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*, a publication of WIPO.

In these Notes, "Article," "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

### INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

#### What parts of the international application may be amended ?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Preliminary Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

**When ?** Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

#### Where not to file the amendments ?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

**How ?** Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

#### What documents must/may accompany the amendments ?

**Letter (Section 205(b)):**

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.